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(54) DIESEL FUEL CONTROL VALVE AND SYSTEM

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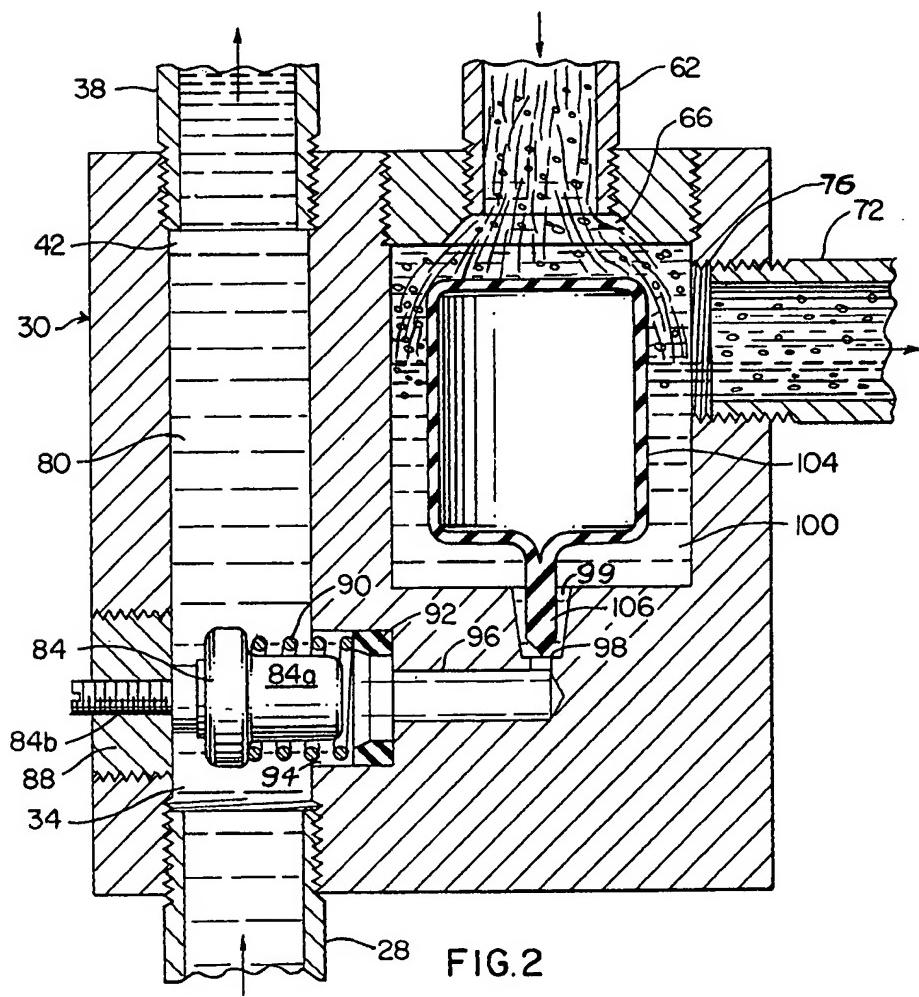
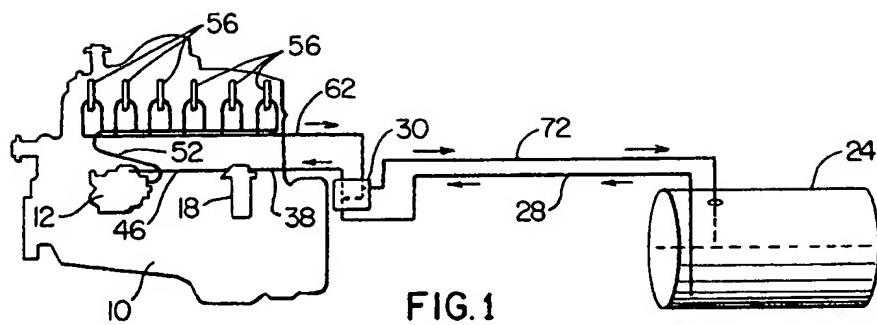
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ABSTRACT

DIESEL FUEL CONTROL VALVE AND SYSTEM

Fuel control mechanism, particularly adapted for control of diesel fuel flow to a deisel engine. The fuel control mechanism includes a housing provided with a plurality of flow passages therethrough. The fuel control mechanism includes a thermally responsive valve member which controls flow of fuel from a source thereof to the diesel engine and which controls the mixing of fuel from a source thereof with unused fuel which flows from the diesel engine. The fuel control mechanism also includes a valve member which controls flow of air which flows from the diesel engine with the unused fuel.



DIESEL FUEL CONTROL VALVE AND SYSTEM

In most diesel engine systems there is a filter device through which fuel must flow to reach the engine. When the engine apparatus is subjected to temperatures in the region of zero degrees Fahrenheit and lower, there is 5 a tendency for ice crystals and wax to form in the diesel fuel. Such conditions cause clogging of the fuel filter device.

Another problem which exists in a conventional diesel engine apparatus relates to the fact that some of the 10 fuel pumped to the engine is not used and the excess fuel which flows from the engine contains a small quantity of entrained gas, in the form of air, which is ordinarily vented from the fuel in the fuel tank as the excess fuel returns to the fuel tank.

15 Various methods have been employed in an attempt to overcome these problems. For example, the conventional diesel fuel oil is mixed with another fuel oil in order to produce a fuel which will flow better in cold weather, even though other characteristics of the fuel may be less desirable.

20 This has not been found to be satisfactory and adds to the expense of the fuel. Heat exchanger devices have been employed to heat the diesel fuel. However, such devices may not provide heat to the fuel until a significant period of time has elapsed, and therefore fuel filter clogging may 25 occur with initial operation.

Another system which has been employed is that of a fuel tank which has a mixing zone with a temperature responsive valve controlling flow of fuel with respect to the mixing zone. Such a system requires a special fuel tank.

5 It is therefore an object of this invention to provide a diesel fuel control valve and system which delivers fuel to a diesel engine at a proper temperature when the diesel engine apparatus is exposed to substantially any outdoor temperature, either cold or warm.

10 This invention comprises diesel engine fuel control apparatus for use in a diesel system which has a diesel engine, a fuel reservoir, fuel conduit means for providing excess quantities of fuel to the diesel engine, and fuel return means for conducting unused fuel from the diesel engine.

15 The fuel control device includes thermally responsive fuel control valve means which controls the mixing of fuel which flows from the diesel engine with fuel flowing from the fuel reservoir. The fuel control device also includes valve means for separating entrained air from the excess fuel which flows from the diesel engine with the unused fuel. Therefore, the air is prevented from flowing back to the diesel engine with the mixed fuel.

FIG. 1 is a diagrammatic view showing a diesel fuel control valve and system of this invention in combination with a diesel engine apparatus.

25 FIG. 2 is a cross-sectional diagrammatic type of view, drawn on a much larger scale than FIG. 1, showing a

diesel fuel control valve of this invention.

FIG. 1 shows a diesel engine 10 provided with a fuel pump 12 and a fuel filter 18. Diesel fuel is supplied to the engine 10 from a fuel tank 24.

5 A fuel supply conduit 28 extends from the tank 24 to a mixing valve 30 of this invention. The fuel supply line 28 is joined to an inlet passage 34 within the mixing valve 30. A fuel supply conduit 38 is joined to an outlet passage 42 of the mixing valve 30 and extends to the fuel 10 filter 18. A conduit 46 extends from the fuel filter 18 to the fuel pump 12, and a conduit 52 extends from the fuel pump 12 to a set of fuel injectors 56 of the engine 10. A conduit 62 leads from the fuel injectors 56 to an inlet passage 66 of the mixing valve 30. A fuel return conduit 72 is joined 15 to an outlet passage 76 of the mixing valve 30 and is also joined to the fuel tank 24.

Between the inlet passage 34 and the outlet passage 42 within the mixing valve 30 is a main passage 80 which is in communication with the inlet passage 34 and the outlet 20 passage 42. Within the main passage 80 is a thermally responsive actuator device 84 which is provided with a container 84a and a stem 84b. The thermally responsive actuator device 84 is preferably of a type in which the stem 84b extends into the container 84a within which there 25 is a quantity of thermally responsive expansible-contractible material. The thermally responsive material within the

container 84a expands significantly in volume when subjected to temperatures above a given predetermined value. Such expansion causes relative movement between the container 84a and the stem 84b. The stem 84b is shown threadedly adjustably attached to a wall 88 of the mixing valve 30, and the position of the container 84a with respect to the connecting passage 96 is adjustable by threaded movement of the stem 84b.

Encompassing the container 84a is a spring 90 which engages the container 84a and also engages an annular seal member 92 which is positioned within an auxiliary passage 94. The auxiliary passage 94 is in communication with a connecting passage 96. The connecting passage 96 is provided with a valve seat 98 which is within a port 99. The port 99 is in communication with a chamber 100. The chamber 100 is in communication with the inlet passage 66 and the outlet passage 76.

Within the chamber 100 is a buoyant member 104 which has a closure element 106 at least partially within the port 99.

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Operation

The fuel pump 12 creates negative pressure conditions which cause fuel to flow from the tank 24, through the fuel supply conduit 28, and into the main passage 80 of the mixing valve 30, through the inlet passage 34 thereof. The fuel then flows through the main passage 80 and outwardly from the

mixing valve 30 through the outlet passage 42. The fuel then flows through the fuel supply conduit 38 through the fuel filter 18, through the conduit 46 to the fuel pump 12, and flows from the fuel pump 12 through the conduit 52 to the fuel injectors 56 of the diesel engine 10. Some of the fuel provides combustion in the diesel engine 10, and some of the fuel flows from the injectors 56 through the conduit 62 to the mixing valve 30 and into the inlet passage 66 thereof. Air is found in the excess fuel which flows from the diesel 10 engine. The fuel and air then flows through the conduit 62 into the chamber 100. This fuel has been heated by the diesel engine 10.

It is important that the air which flows from the diesel engine not be permitted to return to the diesel engine.

15 The closure element 106 of the buoyant member engages the valve seat 98 and closes the port 99 until there is a sufficient volume of fuel with respect to the volume of air within the chamber 100 to cause the buoyant member 104 to float within the chamber 100. Thus, the float 104 senses the density of the mixture of heated fuel and air which flows into engagement therewith and functions in accordance therewith. Therefore, air flowing from the engine 10 through the conduit 62 is not permitted to flow into the connecting passage 96. The air flows outwardly from the chamber 100, through the outlet passage 76 and then flow to the fuel tank 24 through the fuel return conduit 72. The air is then vented from the tank 24 through any suitable vent means, not shown.

25 When density of the mixture of heated fuel and air is sufficient, buoyant member 104 floats in the fuel within the chamber 100 as illustrated in Fig. 2, and the closure element 106

is spaced from the valve seat 98. Therefore, heated fuel flows from the chamber 100 through the port 99, through the connecting passage 96 and into the main passage 80. This heated fuel is mixed with fuel flowing into the main passage 5 80 from the fuel tank 24.

Thus, as operation of the diesel engine 10 is initiated, heated fuel from the engine 10 is mixed with fuel flowing from the tank 24. Therefore, fuel flowing through the filter 18 to the engine 10, has a temperature sufficiently 10 high that clogging of the filter 18 does not occur.

This mixing action continues until the temperature of the fuel engaging the thermally responsive actuator 84 reaches a predetermined value. When this occurs, the container 84a moves in a direction from the stem 84b and toward the 15 connecting passage 96. Thus, the volume of the fuel flowing from the chamber 100 to the main passage 80 is gradually reduced, and the portion of the fuel flowing from the tank 24 into the main passage 80 gradually increases. If the temperature of the fuel engaging the thermally responsive 20 actuator 84 increases to a higher predetermined value, the container 84a moves into a position to close the connecting passage 96, and no fuel flows from the chamber 100 into the main passage 80. Thus, under these conditions all of the fuel flowing through the main passage 80 to the fuel filter 18 25 and to the engine 10 is fuel flowing directly from the tank 24.

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When the temperatures to which the thermally responsive actuator device 84 are reduced to a predetermined value, the thermally responsive material within the container 84a reduces in volume, and the spring 5 90 forces the container 84a to move toward the wall 88.

Thus, the connecting passage 96 is partially or entirely opened for flow of fuel therethrough to the main passage 80, and mixing of heated fuel with fuel from the tank 24 is resumed.

10 Thus, it is understood that the diesel fuel control valve and system of this invention provides fuel which has a sufficient temperature to avoid waxing and clogging of the fuel filter 18. Furthermore, the control valve of this invention effectively limits the 15 temperature of fuel flow to the diesel engine, and does not permit return flow of air to the engine.

What we claim is:

1. The method of supplying diesel fuel to a diesel engine during cold weather conditions in which the diesel engine is supplied with diesel fuel and in which a mixture of heated excess fuel and air flows from the diesel engine, comprising:

providing a supply of diesel fuel, pumping fuel from the supply thereof to the diesel engine, sensing the density of the mixture of heated fuel and air as the mixture of heated fuel and air flows from the diesel engine, separating the air from the heated fuel and directing the flow of heated fuel from the mixture in accordance with the density of the mixture of the heated fuel and air, and mixing the heated fuel with fuel flowing from the supply thereof.

2. The method of supplying diesel fuel to a diesel engine during cold weather conditions in which the diesel engine is supplied with diesel fuel and in which a mixture of heated excess fuel and air flows from the diesel engine, comprising:

providing a supply of diesel fuel, pumping fuel from the supply thereof to the diesel engine, sensing the density of the mixture of heated fuel and air as the mixture of heated fuel and air flows from the diesel engine, separating the air from the heated fuel and directing the flow of heated fuel from the mixture in accordance with the density of the mixture of the heated fuel and air, sensing the temperature of the heated fuel which flows from the mixture and directing the heated fuel to mix with the fuel which flows to the diesel engine from the supply thereof in proportions determined by the temperature of the heated fuel.

3. A method of efficiently preheating diesel fuel being supplied to a diesel engine connected to a fuel supply tank by a fuel supply passage and a fuel return passage, the method comprising the steps of

forming a valve body defining a valve chamber having an upper portion and a lower portion,

connecting the upper portion of the valve chamber to the fuel return passage extending from the engine to the supply tank,

connecting a lower portion of the valve chamber to the fuel supply passage,

positioning a movable buoyant valve member within the valve chamber,

directing a mixture of air and heated return fuel through the fuel return passage into contact with the buoyant valve member,

sensing with the valve member the relative proportions of air and heated fuel within the mixture,

separating air from the heated return fuel and air mixture while the mixture is contacting the valve member and directing the separated air through the fuel return passage to the supply tank, and

controlling with the buoyant valve member a flow of heated return fuel from the lower portion of the valve chamber into the fuel supply passage in response to the relative proportions of air and heated return fuel forming the mixture within the valve chamber adjacent the valve member.

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Docket 2524-D

4. A method as defined in claim 3 and including the step of further controlling the flow of heated return fuel into the fuel supply passage with a thermally responsive valve unit positioned to sense the temperature of the heated return fuel.

5. A method as defined in claim 3 or 4 including the steps of forming within the valve body a fuel recirculating passage with a surrounding annular valve seat disposed at the bottom of the valve chamber, and providing the buoyant valve member with downwardly projecting closure element for cooperating with the valve seat to control the flow of heated return fuel through the fuel recirculating passage into the fuel supply passage.

6. A method as defined in claim 3 or 4 including the step of positioning the buoyant valve member substantially within the center portion of the valve chamber, and directing the mixture of air and heated return fuel downwardly into the valve chamber from above the valve member.

7. A method as defined in claim 3 or 4 including the steps of forming a portion of the fuel supply passage within the valve body, and forming a fuel recirculating passage within the valve body to connect the lower portion of the valve chamber to the portion of the fuel supply passage.

8. A method as defined in claim 4 and including the steps of forming a portion of the fuel supply passage within the valve body, forming a fuel recirculating passage within the valve body to connect the lower portion of the valve chamber to the portion of the fuel supply passage, and positioning the thermally responsive valve unit within the fuel recirculating passage within the valve body.

9. The method of supplying diesel fuel to a diesel engine during cold weather conditions in which the diesel engine is supplied with diesel fuel and in which a mixture of heated excess fuel and air flows from the diesel engine, comprising:

providing a supply of diesel fuel,

pumping fuel from the supply thereof to the diesel engine,

sensing the ratio of the volume of heated fuel with respect to the volume of air therein as the mixture of heated fuel and air flows from the diesel engine,

separating the air from the heated fuel and directing flow of the heated fuel from the mixture in accordance with said ratio and directing the heated fuel to mix with fuel which flows to the diesel engine from the supply of diesel fuel.

10. The method of supplying diesel fuel to a diesel engine during cold weather conditions in which the diesel engine is supplied with diesel fuel and in which a mixture of heated excess fuel and air flows from the diesel engine, comprising:

providing a supply of diesel fuel,

pumping fuel from the supply thereof to the diesel engine,

sensing the ratio of the volume of heated fuel with respect to the volume of air therein as the mixture of heated fuel and air flows from the diesel engine,

separating the air from the heated fuel and directing flow of the heated fuel from the mixture in accordance with said ratio, sensing the temperature of the heated fuel which flows from the mixture and directing the heated fuel to mix with the fuel which flows to the diesel engine from the supply thereof in proportions determined by the temperature of the heated fuel.

11. A diesel fuel control unit for control of diesel fuel to a diesel engine under low temperature conditions in which fuel flows to the diesel engine from a supply of diesel fuel and in which excess heated fuel flows from the diesel engine, the excess heated fuel containing air entrained therein, comprising: a housing provided with a fuel control chamber which receives a mixture of heated fuel and entrained air, fuel control means within the fuel control chamber for sensing the density of the mixture of heated fuel and air and for separating the heated fuel and air and controlling flow of heated fuel from the fuel control chamber in accordance with the density of the mixture of heated fuel and air in the fuel control chamber.

12. The diesel fuel control unit of Claim 11 in which the control means within the fuel control chamber includes a buoyant member.

13. The diesel fuel control unit of Claim 11 in which the housing includes passage means for flow of heated fuel from the chamber to mix with fuel flowing to the diesel engine from the supply of diesel fuel, and in which the fuel control means includes a buoyant member and valve means movable therewith for controlling flow of heated fuel, the buoyant member being engaged by the heated fuel and air and sensing the density of the mixture of heated fuel and air within the chamber, the buoyant member rising and falling in accordance with the density of the mixture of heated fuel and air within the chamber.

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14. A fuel control valve device adapted for use in a diesel engine fuel supply system including a fuel supply tank, a fuel supply conduit extending from the tank to the engine, and a heated fuel and air conduit having an inlet and an outlet and extending from the engine to the fuel supply tank for conducting from the engine a mixture of heated fuel and air entrained in the heated fuel, said fuel control valve device comprising a valve body defining a valve chamber having an upper portion and a lower portion, means defining a fuel supply passage connected to the fuel supply conduit, said valve body further defining a fuel recirculating passage connecting said lower portion of said valve chamber to said fuel supply passage, means forming an annular valve seat surrounding said fuel recirculating passage, a buoyant valve member disposed for movement upwardly and downwardly within said valve chamber, said outlet connecting said heated fuel and air conduit to said valve chamber for directing the mixture of heated fuel and entrained air into direct fluid contact with said buoyant valve member within said valve chamber under all operating conditions, a closure element connected to said buoyant valve member and positioned adjacent said valve seat for controlling the flow of heated fuel from said valve chamber through said recirculating passage into said fuel supply passage in response to movement of said buoyant valve member within said valve chamber, said buoyant valve member being positioned to receive and sense the mixture of heated fuel and entrained air flowing through said fuel and air conduit, air being separated from the mixture adjacent said buoyant valve member and being conducted to the fuel supply tank by said heated fuel and air conduit, to provide a compact valve system for efficiently using the return fuel heated by the engine and adapted to require relatively small space adjacent the engine.

15. A fuel control valve device adapted for use in a diesel engine fuel supply system including a fuel supply tank, a fuel supply conduit extending from the tank to the engine, and a heated fuel and air conduit having an inlet and an outlet and extending from the engine to the fuel supply tank for conducting from the engine a mixture of heated fuel and air entrained in the heated fuel, said fuel control valve device comprising a valve body defining a valve chamber having an upper portion and a lower portion, means defining a fuel supply passage connected to the fuel supply conduit, said valve body further defining a fuel recirculating passage connecting said lower portion of said valve chamber to said fuel supply passage, means forming an annular valve seat surrounding said fuel recirculating passage, a buoyant valve member disposed for movement upwardly and downwardly within said valve chamber, said outlet connecting said heated fuel and air conduit to said valve chamber for directing the mixture of heated fuel and entrained air into direct fluid contact with said buoyant valve member within said valve chamber under all operating conditions, a closure element connected to said buoyant valve member and positioned adjacent said valve seat for controlling the flow of heated fuel from said valve chamber through said recirculating passage into said fuel supply passage in response to movement of said buoyant valve member within said valve chamber, said buoyant valve member being positioned to receive and sense the mixture of heated fuel and entrained air flowing through said fuel and air conduit, air being separated from the mixture adjacent said buoyant valve member and being conducted to the fuel supply tank by said heated fuel and air conduit, and a thermally responsive valve unit supported by said valve body within said fuel recirculating passage and cooperating with said buoyant valve member for controlling the flow of heated fuel through said recirculating passage in response to the temperature of the fuel, to provide a compact valve system for efficiently using the return fuel heated by the engine and adapted to require relatively small space adjacent the engine.

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16. A fuel control valve device adapted for use in a diesel engine fuel supply system including a fuel supply tank, a fuel supply conduit extending from the tank to the engine, and a heated fuel and air conduit having an inlet and an outlet and extending from the engine to the fuel supply tank for conducting from the engine a mixture of heated fuel and air entrained in the heated fuel, said fuel control valve device comprising a valve body defining a valve chamber having an upper portion and a lower portion, means defining a fuel supply passage connected to the fuel supply conduit, said valve body further defining a fuel recirculating passage connecting said lower portion of said valve chamber to said fuel supply passage, means forming an annular valve seat surrounding said fuel recirculating passage, a buoyant valve member disposed for movement upwardly and downwardly within said valve chamber and positioned generally at the center of said valve chamber, said outlet connecting said heated fuel and air conduit to said valve chamber for directing the mixture of heated fuel and entrained air into direct fluid contact with said buoyant valve member within said valve chamber under all operating conditions, a closure element connected to said buoyant valve member and positioned adjacent said valve seat for controlling the flow of heated fuel from said valve chamber through said recirculating passage into said fuel supply passage in response to movement of said buoyant valve member within said valve chamber, said buoyant valve member being positioned to receive and sense the mixture of heated fuel and entrained air flowing through said fuel and air conduit, air being separated from the mixture adjacent said buoyant valve member and being conducted to the fuel supply tank by said heated fuel and air conduit, to provide a compact valve system for efficiently using the return fuel heated by the engine and adapted to require relatively small space adjacent the engine.

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17. A fuel control valve device adapted for use in a diesel engine fuel supply system including a fuel supply tank, a fuel supply conduit extending from the tank to the engine, and a heated fuel and air conduit having an inlet and an outlet and extending from the engine to the fuel supply tank for conducting from the engine a mixture of heated fuel and air entrained in the heated fuel, said fuel control valve device comprising a valve body defining a valve chamber having an upper portion and a lower portion, means defining a fuel supply passage connected to the fuel supply conduit, said valve body further defining a fuel recirculating passage connecting said lower portion of said valve chamber to said fuel supply passage, means forming an annular valve seat at the lower portion of said valve chamber and surrounding said fuel recirculating passage, a buoyant valve member disposed for movement upwardly and downwardly within said valve chamber, said outlet connecting said heated fuel and air conduit to said valve chamber for directing the mixture of heated fuel and entrained air into direct fluid contact with said buoyant valve member within said valve chamber under all operating conditions, a closure element connected to and projecting downwardly from said buoyant valve member and positioned adjacent said valve seat for controlling the flow of heated fuel from said valve chamber through said recirculating passage into said fuel supply passage in response to movement of said buoyant valve member within said valve chamber, said buoyant valve member being positioned to receive and sense the mixture of heated fuel and entrained air flowing through said fuel and air conduit, air being separated from the mixture adjacent said buoyant valve member and being conducted to the fuel supply tank by said heated fuel and air conduit, to provide a compact valve system for efficiently using the return fuel heated by the engine and adapted to require relatively small space adjacent the engine.

18. A fuel control valve device adapted for use in a diesel engine fuel supply system including a fuel supply tank, a fuel supply conduit extending from the tank to the engine, and a heated fuel and air conduit having an inlet and an outlet and extending from the engine to the fuel supply tank for conducting from the engine a mixture of heated fuel and air entrained in the heated fuel, said fuel control valve device comprising a valve body defining a valve chamber having an upper portion and a lower portion, said valve body also defining a fuel supply passage connected to the fuel supply conduit, said valve body further defining a fuel recirculating passage connecting said lower portion of said valve chamber to said fuel supply passage, means forming an annular valve seat at said lower portion of said valve chamber and surrounding said fuel recirculating passage, a buoyant valve member disposed for movement upwardly and downwardly within said valve chamber and positioned within a center portion of said valve chamber, said outlet connecting said heated fuel and air conduit to said valve chamber for directing the mixture of heated fuel and entrained air into direct fluid contact with said buoyant valve member within said valve chamber under all operating conditions, a closure element connected to and projecting downwardly from said buoyant valve member and positioned adjacent said valve seat for controlling the flow of heated fuel from said valve chamber through said recirculating passage into said fuel supply passage in response to movement of said buoyant valve member within said valve chamber, said buoyant valve member being positioned to receive and sense the mixture of heated fuel and entrained air flowing through said fuel and air conduit, air being separated from the mixture adjacent said buoyant valve member and being conducted to the fuel supply tank by said heated fuel and air conduit, and a thermally responsive valve unit supported by said valve body within said fuel recirculating passage and cooperating with said buoyant valve member for controlling the flow of heated fuel through said recirculating passage in response to the temperature of the fuel, to provide a compact valve system for efficiently using the return fuel heated by the engine and adapted to require relatively small space adjacent the engine.

